

Appl. No. 10/517,184
Amdt dated June 20, 2006
Reply to Office Action of March 20, 2006

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

1. (currently amended) A hydraulic stepless transmission comprising
a first hydraulic system that has a first plunger and a swash plate, which the first plunger abuts on,

a second hydraulic system that has a second plunger and a swash plate, which the second plunger abuts on, and

a cylinder block, wherein formed in the cylinder block are first and second plunger holes that contain the first and second plungers, respectively, a hydraulic closed circuit that connects the first and second plunger holes, and a distributing valve hole that contains a distributing valve for switching flow direction of hydraulic fluid in the hydraulic closed circuit,

a shaft ~~[[is]]~~ provided that extends through the cylinder block, the shaft and the cylinder block synchronously rotate, the first and second plunger holes are formed in parallel to the shaft, respectively, and the swash plate of the second hydraulic system is rotatably supported around the shaft, the first and second plungers are urged toward the swash plates by springs provided in the corresponding first and second plunger holes, respectively,

first and second combined thrust and radial bearings are provided supporting the shaft in which each includes inner and outer rings, the swash plate of the first hydraulic system is supported by the outer ring of the first combined thrust and radial bearing, the swash plate of the second hydraulic system is supported by the outer ring of the second combined thrust and radial bearing, and movement of inner rings of the first and second combined thrust and radial bearings in an axial direction of the shaft is regulated, and

a high pressure oil chamber and a low pressure oil chamber juxtaposed along an axial direction in the cylinder block so as to be closer to the shaft than the first and second plunger holes;

wherein a spline section is formed in the shaft, and the shaft is fit into the cylinder block at the spline section; and

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wherein the low-pressure oil chamber communicates with the spline section of the shaft.

2. (previously presented) The hydraulic stepless transmission according to claim 1, further comprising a first regulating member, which has a surface that is parallel to a side face of the inner ring of the first combined thrust and radial bearing, and is spaced apart by a minute distance from the side face of the inner ring, and a second regulating member, which has a surface that is parallel to a side face of the inner ring of the second combined thrust and radial bearing and is spaced apart by a minute distance from the side face of the inner ring.

3. (previously presented) The hydraulic stepless transmission according to claim 1, wherein the distributing valve hole is located in parallel to the shaft and is closer to the shaft than the plunger hole; and

wherein an oil passage that connects the plunger hole and the distributing valve hole is formed in a radial direction.

4. (previously presented) The hydraulic stepless transmission according to claim 1, wherein the distributing valve hole is formed in parallel to the shaft so as to extend through the cylinder block.

5. (canceled)

6. (previously presented) The hydraulic stepless transmission according to claim 1, wherein an outer circumferential surface of the swash plate of the second hydraulic system is formed through machining by using a first machining central axis, which is a line perpendicular to a swash plate surface of this swash plate, a machining central axis, which is a center line of the shaft, and a second machining central axis, which is a line that is parallel to a center line of the shaft and is offset to a side where a gap narrows between the swash plate surface and a surface opposite to the swash plate surface.

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7. (currently amended) A power transmission comprising: [[:]]

a hydraulic stepless transmission including a cylinder block and a first hydraulic system which has a first plunger and a swash plate, which the first plunger abuts on, and a second hydraulic system, which has a second plunger and a swash plate that the second plunger abuts on, wherein first and second plunger holes, which contain the first and second plungers, respectively, are formed in the cylinder block,

a hydraulic closed circuit that connects the first and second plunger holes is formed in the cylinder block,

a distributing valve hole that contains a distributing valve for switching flow direction of hydraulic fluid in the hydraulic closed circuit is formed in the cylinder block,

a shaft [[:is]] provided that extends through the cylinder block, the shaft and the cylinder block synchronously rotate, the first and second plunger holes are formed in parallel to the shaft respectively, and the swash plate of the second hydraulic system is rotatably supported around the shaft, the first and second plungers are urged toward the swash plates by springs provided in the corresponding first and second plunger holes respectively, first and second combined thrust radial bearings are provided that each include inner and outer rings, with the swash plate of the first hydraulic system supported by the outer ring of the first combined thrust and radial bearing that supports the shaft, the swash plate of the second hydraulic system is supported by the outer ring of the second combined thrust and radial bearing that supports the shaft, and movement of the inner rings of the first and second combined thrust and radial bearings in an axial direction of the shaft is regulated;

a high pressure oil chamber and a low pressure oil chamber juxtaposed along an axial direction in the cylinder block so as to be closer to the shaft than the first and second plunger holes, wherein a spline section is formed in the shaft, with the shaft fit into the cylinder block at the spline section, and the low-pressure oil chamber communicates with the spline section of the shaft;

a device which transmits or shuts down power to the shaft; and

a device which inputs turning force from the swash plate of the second hydraulic system and outputs rotation in a direction identical or reverse to that of the swash plate of the second hydraulic system.

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8. (previously presented) The hydraulic stepless transmission according to claim 7, further comprising a first regulating member having a surface parallel to a side face of the inner ring of the first combined thrust and radial bearing, and spaced apart by a minute distance from the side face of the inner ring, and a second regulating member having a side face parallel to a side face of the inner ring of the second combined thrust and radial bearing and spaced apart by a minute distance from the side face of the inner ring.

9. (previously presented) The hydraulic stepless transmission according to claim 7, wherein the distributing valve hole is parallel to the shaft and closer to the shaft than the plunger hole, wherein an oil passage that connects the plunger hole and the distributing valve hole is formed in a radial direction.

10. (previously presented) The hydraulic stepless transmission according to claim 7, wherein the distributing valve hole is formed parallel to the shaft so as to extend through the cylinder block.

11. (canceled)

12. (previously presented) The hydraulic stepless transmission according to claim 7, wherein an outer circumferential surface of the swash plate of the second hydraulic system is formed through machining by using a first machining central axis, which is a line perpendicular to a swash plate surface of this swash plate, a machining central axis, which is a center line of the shaft, and a second machining central axis, which is a line that is parallel to a center line of the shaft and is offset to a side where a gap narrows between the swash plate surface and a surface opposite to the swash plate surface.

13. (currently amended) A hydraulic stepless transmission comprising:

a first hydraulic system including a first plunger and a swash plate, which the first plunger abuts on;

a second hydraulic system including a second plunger and a swash plate, which the

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second plunger abuts on;

a cylinder block including:

first and second plunger holes containing first and second plungers and springs;

a hydraulic closed circuit connecting the first and second plunger holes; and

a distributing valve hole containing a distributing valve for switching flow direction of hydraulic fluid in the hydraulic closed circuit;

a shaft extending through the cylinder block, in which the shaft and the cylinder block synchronously rotate, the first and second plunger holes are formed parallel to the shaft, and the swash plate of the second hydraulic system is rotatably supported around the shaft, the first and second plungers are urged toward the swash plates by the springs of the first and second plunger holes;

first and second combined thrust and radial bearings supporting the shaft in which each includes inner and outer rings, with the swash plate of the first hydraulic system supported by the outer ring of the first combined thrust and radial bearing, and the swash plate of the second hydraulic system supported by the outer ring of the second combined thrust and radial bearing; and

means for regulating movement of inner rings of the first and second combined thrust and radial bearings in an axial direction of the shaft; and

a high pressure oil chamber and a low pressure oil chamber juxtaposed along an axial direction in the cylinder block so as to be closer to the shaft than the first and second plunger holes, wherein a spline section is formed in the shaft, and the shaft is fit into the cylinder block at the spline section, and the low-pressure oil chamber is in fluid communication with the spline section of the shaft.

14. (previously presented) The hydraulic stepless transmission according to claim 13, wherein the means for regulating movement includes:

a first regulating member having a surface parallel to a side face of the inner ring of the first combined thrust and radial bearing, and spaced apart by a minute distance from the side face of the inner ring; and

a second regulating member having a surface parallel to a side face of the inner ring of

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the second combined thrust and radial bearing and spaced apart by a minute distance from the side face of the inner ring.

15. (previously presented) The hydraulic stepless transmission according to claim 13, wherein the distributing valve hole is located in parallel to the shaft and closer to the shaft than the plunger hole, and an oil passage connecting the plunger hole and the distributing valve hole is formed in a radial direction.

16. (previously presented) The hydraulic stepless transmission according to claim 13, wherein the distributing valve hole is formed parallel to the shaft so as to extend through the cylinder block.

17. (canceled) The hydraulic stepless transmission according to claim 13, further comprising a high pressure oil chamber and a low pressure oil chamber juxtaposed along an axial direction in the cylinder block so as to be closer to the shaft than the first and second plunger holes, wherein a spline section is formed in the shaft, and the shaft is fit into the cylinder block at the spline section, and the low-pressure oil chamber is in fluid communication with the spline section of the shaft.

18. (previously presented) The hydraulic stepless transmission according to claim 13, wherein an outer circumferential surface of the swash plate of the second hydraulic system is formed through machining by using a first machining central axis, which is a line perpendicular to a swash plate surface of this swash plate, a machining central axis, which is a center line of the shaft, and a second machining central axis, which is a line that is parallel to a center line of the shaft and is offset to a side where a gap narrows between the swash plate surface and a surface opposite to the swash plate surface.